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## Impacts of Shallow Geothermal Energy on Groundwater Quality

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The use of shallow geothermal energy (SGE) systems to acclimatize buildings has increased exponentially in the Netherlands and worldwide. In certain areas, SGE systems are constructed in aquifers also used for drinking water supply raising the question of potential groundwater quality impact. This PhD thesis investigated this question with field and laboratory experiments, and reactive transport models. The results showed SGE systems can influence groundwater quality in a number of ways. Most prominent in low temperature (<20°C) systems is the physical mixing of deep and shallow groundwater of different quality distorting the natural water quality stratification in aquifers. At temperature of 25°C and beyond certain trace elements were observed to mobilize in laboratory experiments, and beyond 40°C redox conditions changed significantly while the microbial community shifted towards a thermophilic community. Based on the results of this research, guidelines are presented for monitoring and permitting of SGE systems.

Impacts of shallow geothermal energy on groundwater quality

# Impacts of shallow geothermal energy on groundwater quality

A hydrochemical and geomicrobial study of the effects of ground source heat pumps and aquifer thermal energy storage

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